GLAS Standard Data Products Specification - Level 1
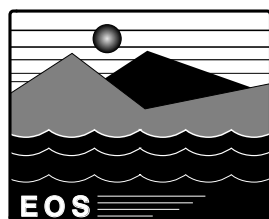
Preliminary

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EOS

Foreword

This preliminary document defines the Level One GLAS standard data products. This Standard Data Products Specification is developed under the structure of the NASA STD-2100-91, a NASA standard defining a four-volume set of documents to cover an entire software life cycle. Under this standard a section of any volume may, if necessary, be rolled out to its own separate document. This document is a roll out of the GLAS ESDIS Software Detailed Design Specification under the Product Specification Volume.

This document was prepared by the Observational Science Branch at NASA GSFC/ WFF, Wallops Island, VA, in support of B. E. Schutz, GLAS Science Team Leader for the GLAS Investigation. This work was performed under the direction of David W. Hancock, III, who may be contacted at (804) 824-1238, hancock@osb1.wff.nasa.gov (e-mail), or (804) 824-1036 (FAX).

Items to be Resolved

1) Review data resolutions and determine if correct.

2) Understand and reflect the requirements for GPS data such as the GPS navigation messages.

3) Determine whether two range correction values are needed (for 1064 and 532 nm data).

4) Define meaningful data organization (file aggregation).

Table of Contents

Section 1   Introduction

Section 2   Related Documentation

Section 3   Purpose and Description of the Data Products

Section 4   Environment

Section 5   Data Flow Characteristics

Section 6   Data Product Definitions

Appendix A   EOSDIS Standard Label - Contents & Description

Appendix B   Format

Appendix C   Detailed Data Contents & Description

List of Figures

List of Tables

Preface

The GEOSCIENCE LASER ALTIMETER SYSTEM (GLAS) is a part of the EOS program. This laser altimetry mission will be carried on the spacecraft designated EOS LASER ALT. The GLAS laser is a frequency-doubled, cavity-pumped, solid state Nd:YAG laser.

This document addresses the data flow, interfaces, record and data formats associated with the GLAS Level 1 standard data products. GLAS Level 1 standard data products are composed of Level 1A and Level 1B data products. The term "standard data products" refers to those EOS instrument data products listed in the Earth Science Data and Information System (ESDIS) Project data base that are routinely generated within the EOSDIS Core System (ECS) Distributed Active Archive Center (DAAC) or Science Computing Facilities (SCFs). Each data product has a unique Product Identification code assigned by the EOS Senior Project Scientist.

Level 1A and Level 1B Data Products are composed from those Level 0 data that have been reformatted or reversibly transformed to corrected and calibrated data in physical units at the full instrument rate and resolution.

Introduction

1.1 Identification of Document

This document is identified as the GLAS Level 1 Standard Data Products Specification. The unique document identification number within the GLAS Ground Data System numbering scheme is GLAS-DPS-2621. Progressive editions of this document will be uniquely identified by the cover and page date marks.

1.2 Scope of Document

This document addresses the purpose, usage, and description of the GLAS Level 1 Standard Data Products. The intended audience for this document is the GLAS Science and Instrument Engineering Teams, the ESDIS Project and related focus teams, the community of EOS data users and investigators, and the GLAS Ground Data System Team.

1.3 Purpose and Objectives of Document

The purpose of the GLAS Level 1 Standard Data Products Specification is to provide a high-level descriptive document for the data products. This document describes the purpose, usage, content, and format of the GLAS Level 1 Data Products. It describes the representation and definition of the GLAS data elements constituting the EOS data parameters. It further describes the structure, physical storage, organization, and access characteristics of the GLAS Level 1 Data Products. The document additionally describes file transfer methods to support product access, the data flow associated with the data products, and the data storage and generation characteristics of the data products.

1.4 Document Status and Schedule

Table 1-1 "Document Delivery Schedule" lists the planned editions and updates for this document:

Table 1-1   Document Delivery Schedule

Edition/Revision Designation	Document Edition Description	Edition Delivery Focus	Activity/ Delivery Dates
DRAFT 1	incorporate revised EOSDIS terminology	Internal Review	December 1995
PRELIMINARY	revised document edition delivered to EOSDIS by GLAS Science Team Leader	EOSDIS, EOS	December 1995

1.5   Document Organization

This document's outline is assembled in a form similar to those presented in the NASA Software Engineering Program [Information Document 2.3a].

Related Documentation

2.1   Parent Documents

The GLAS Level 1 Standard Data Products Specification is considered a "roll-out" from the Product Specification as the parent document or volume. Specific topics pertaining to data descriptions are located in the External Interface section under the Detailed Design document template.

This document is subordinate to any top-level mission or instrument management plan documents, and as such, recognizes these documents as external parent documents in lineage. The recognized external EOSDIS and GLAS parent documents superior to the GLAS Level 1 Standard Data Products Specification are listed below.

   a) *EOS ALT/GLAS Mission Requirements Document,* Version 1.5, July 1993, Center for Space Research, University of Texas at Austin.

   b) *GLAS Science Software Development Management Plan,* Preliminary, December 31, 1995, NASA Goddard Space Flight Center, Wallops Flight Facility.

2.2   Applicable Documents

The following documents are related to, or contain policies or references pertinent to the contents of the GLAS Level 1 Standard Data Products Specification.

   a) *Data Production Software, Data Management, and Flight Operations Working Agreement for GLAS,* TBD, NASA Goddard Space Flight Center.

   b) *GLAS EOSDIS Algorithm Theoretical Basis Document,* TBD, NASA Goddard Space Flight Center.

2.3   Information Documents

The following documents are provided as sources of information that provide background or supplemental information that may clarify or amplify material in the GLAS Level 1 Standard Data Products Specification.

   a) *NASA Software Documentation Standard Software Engineering Program,* NASA, NASA-STD-21000-91, July 29, 1991.

   b) *The Geoscience Laser Altimetry/Ranging System,* IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-25, No. 5, September 1987.

   c) *EOS Altimetry/GLAS Phase-A Study,* NASA Goddard Space Flight Center, November 1995.

   d) *Memorandum: GLAS Data Products, Center for Space Research,* University of Texas at Austin, December 23, 1993.

Section 3
Purpose and Description of the Data Products

3.1   Purpose of the Data Products

The purpose of the GLAS Level 1 Standard Data Products is to provide the initial reduced GLAS instrument data. The GLAS Level 1A Data Product and the GLAS Level 1B Data Products, produced on the ECS DAAC, contain the Level 0 instrument data for subsequent Level 2 data processing. This processing includes the generation of the data product named the "Level 1A Product" (GLA01), the data product named the "Level 1B Altimeter Height" (GLA03), and the data product named the "Level 1B Product, Atmosphere" (GLA04).

Concurrently, the GLAS Science Team is generating the (GLA02) Level 1B Data Product within the GLAS Science Computing Facility (SCF). The data from the star cameras, the 3-axis gyroscope, the angular displacement sensors, and the GPS receiver from the spacecraft are collected along with ancillary data comprising polar motion and Earth rotation data, magnetic and solar flux data, and meteorological data. This Level 1B Data Product is named the "Level 1B Non-Instrument Corrections" (GLA02). It is intended to contain the required corrections from precision orbit, instrument pointing, and atmospheric delay sources necessary to produce the GLAS Level 2 Data Products.

The GLAS Level 1A Data Product and GLAS Level 1B Data Products produced as standard data products in the ECS DAAC are available for product quality monitoring (i.e., quality assurance) on the GLAS SCF processors. The GLAS Level 1A and Level 1B Data Products are available to the ECS Operations Team for Level 2 Data Products generation and to the EOS data user community for retrieval and analysis purposes from the ECS DAAC product storage facility.

The Science Team-produced GLA02 Level 1B Data Product is generated in the GLAS SCF, and quality assurance for this product is performed within the GLAS SCF. This Level 1B Data Product must be delivered to the ECS DAAC for GLAS product generation, for inclusion in the product storage facility. After delivery to ESDIS, this Level 1B Data Product is available to the EOSDIS Operations Team for Level 2 Data Products generation and to EOS data users for science processing from the DAAC product storage facility.

3.2   Description of the Data Products

The GLAS Level 1 Standard Data Products are routinely generated by ECS and the GLAS Science Team. Table 3-1 "GLAS Level 1 Standard Data Products" identifies the Level 1 Data Products and shows the composition of each of the four Level 1 Data Products. Each Data Product consists of one or more specific EOS Data Parameters. The EOS Data Parameters are uniquely identified by their Parameter Number. Table 3-2 "GLAS Level 1 Standard Data Parameters" enumerates the EOS Data Parameters composing the four Data Products. The contents of this table are in ascending order

according to Product Identification, and include the EOS Parameter Name, the Parameter Number, i.e., the data product to which the parameter belongs, and the Number of Elements composing the Data Parameter. The Level 1B data products are located using precision orbit determination georeference ancillary data.

Table 3-1   GLAS Level 1 Standard Data Products

Product ID (Identification)	Product Name	Product Level	Number of Parameters
GLA01	Level 1A Product	1A	9
GLA02	Level 1B Non-Instrument Corrections	1B	3
GLA03	Level 1B Altimeter Height	1B	1
GLA04	Level-1B Product, Atmosphere	1B	1

Table 3-2   GLAS Level 1 Standard Data Parameters

Product ID	Parameter Number	Parameter Name	Number of Elements
GLA01	4343	Pulse Travel Time	14
GLA01	4344	Return Pulse Waveform	4
GLA01	4345	Transmit Pulse Energy	5
GLA01	4346	Receive Pulse Energy	5
GLA01	4347	Cumulative Backscatter	6
GLA01	4348	Cloud Top Height	3
GLA01	4349	GPS Pseudorange/Phase	8
GLA01	4350	Star Camera/Gyro	6
GLA01	4351	Calibration	3
GLA02	4352	Precision Orbit Position	4
GLA02	4353	Precision Attitude	2
GLA02	4354	Atmospheric Delay	2
GLA03	4355	Altimeter Height Vector	10
GLA04	2104	Level-1B Backscatter	8

Each EOS Data Parameter is decomposable into one or more GLAS Data Elements. A GLAS Data Element is either an Item or an Array of Items as indicated in Table 3-3 "GLAS Level 1 Standard Data Elements".

Table 3-3   GLAS Level 1 Standard Data Elements

Parameter Number	Element Name	Elem /Sec	Bytes/ Item	Items/ Elem	Total Bytes
2104	Attenuated Backscatter Vertical Profile	5	2.00	535	5350.00
2104	Background Radiance	5	4.00	2	40.00
2104	Solar Angle	1	4.00	1	4.00
2104	Attenuated Backscatter Vertical Profile Quality Flag	1	8.00	5	40.00
2104	Attenuated Backscatter Vertical Profile Use Flag	1	8.00	5	40.00
2104	Coordinate Data, POD	1	8.00	3	24.00
2104	Orbit Number	1	2.00	1	2.00
2104	Time of First Sample	1	8.00	1	8.00
4343	1064 nm Range TIU Time	40	4.00	1	160.00
4343	Time of First Pulse	1	8.00	1	8.00
4343	Time Correction	1	4.00	1	4.00
4343	1064 nm Range Travel Time Correction	40	4.00	1	160.00
4343	Range Pulse Quality Flag	1	8.00	6	48.00
4343	Range Pulse Use Flag	1	8.00	6	48.00
4343	Return Pulse Quality Flag	1	8.00	6	48.00
4343	Return Pulse Use Flag	1	8.00	6	48.00
4343	Status Flags	40	1.00	1	40.00
4343	Laser Shot GPS Timing Vernier	1	2.50	1	2.50
4343	Background Noise Counter	2	4.00	1	8.00
4343	Channel Number	40	0.50	1	20.00
4343	Range Gate Delay	2	2.00	1	4.00
4343	Range Gate Width	2	2.00	1	4.00
4344	1064 nm Range Waveform Scaling Factor	40	1.00	1	40.00
4344	1064 nm Range Waveform Multiplier	40	1.00	1	40.00
4344	1064 nm Range Waveform	40	1.00	400	16000.00
4344	1064 nm Range Waveform Threshold	2	1.00	4	8.00

Table 3-3   GLAS Level 1 Standard Data Elements (Continued)

Parameter Number	Element Name	Elem /Sec	Bytes/ Item	Items/ Elem	Total Bytes
4345	1064 nm Laser Transmit Energy, counts	40	2.00	1	80.00
4345	1064 nm Laser Transmit Energy	40	4.00	1	160.00
4345	532 nm Laser Transmit Energy, counts	5	2.00	1	10.00
4345	532 nm Laser Transmit Energy	5	4.00	1	20.00
4345	1064 nm Laser Start Detector Threshold	40	1.00	1	40.00
4346	1064 nm Background Signal	40	2.00	1	80.00
4346	1064 nm Range Received Energy, Counts	40	2.00	1	80.00
4346	1064 nm Range Received Energy	40	4.00	1	160.00
4346	532 nm Channel Received Energy	5	4.00	1	20.00
4346	532 nm Channel Received Energy, counts	5	1.00	1	5.00
4347	532 nm Atmosphere Signal Histogram	5	2.00	535	5350.00
4347	1064 nm Cloud Waveform	40	1.00	30	1200.00
4347	532 nm Atmosphere Signal Histogram Scaling Factor	5	1.00	1	5.00
4347	1064 nm Cloud Waveform Scaling Factor	40	1.00	1	40.00
4347	1064 nm Cloud Waveform Quality Flag	1	8.00	5	40.00
4347	1064 nm Cloud Waveform Use Flag	1	8.00	5	40.00
4348	Cloud Delta Range from 1064 nm	5	2.00	1	10.00
4348	Threshold Cloud Top Height from 1064 nm	40	4.00	1	160.00
4348	Threshold D/A Setting	2	1.00	1	2.00
4349	GPS ID	1	1.00	12	12.00
4349	GPS Time	1	8.00	12	96.00
4349	Carrier Phase L1	1	8.00	12	96.00
4349	Carrier Phase L2	1	8.00	12	96.00
4349	Pseudorange L1	1	8.00	12	96.00
4349	Pseudorange L2	1	8.00	12	96.00
4349	GPS SNR	1	1.00	12	12.00
4349	GPS Quality Flag	1	8.00	1	8.00
4350	Star (Laser) Coordinate X	10	2.00	12	240.00

Table 3-3   GLAS Level 1 Standard Data Elements (Continued)

Parameter Number	Element Name	Elem /Sec	Bytes/ Item	Items/ Elem	Total Bytes
4350	Star Camera Time	10	8.00	2	160.00
4350	Star (Laser) Coordinate Y	10	2.00	12	240.00
4350	Star (Laser) Intensity	10	1.00	12	120.00
4350	External Laser Pointing Monitor	40	1.25	4	200.00
4350	Star Camera Image	1	1.00	512	512.00
4351	Calibration Mode (OTS)	1	2.00	100	200.00
4351	Engineering	1	2.00	100	200.00
4351	Telemetry Headers	1	1.00	100	100.00
4352	Coordinate Data, POD	1	8.00	3	24.00
4352	Orbit Number	1	2.00	1	2.00
4352	Time, POD	1	8.00	1	8.00
4352	Coordinate Data, POD, Quality Flag	1	4.00	1	4.00
4353	Laser Pointing	40	4.00	2	320.00
4353	Time of First Pulse	1	8.00	1	8.00
4354	Meteorological Data	1	4.00	5	20.00
4354	Meteorological Data Quality Flag	1	2.00	1	2.00
4355	Height Vector	40	4.00	3	480.00
4355	Height Vector Correction, Atmosphere	1	4.00	1	4.00
4355	Height Vector Correction, Calibration	1	4.00	1	4.00
4355	Height Vector Correction, Laser Pointing	40	4.00	1	160.00
4355	Height Vector Quality Flag	1	8.00	2	16.00
4355	Range Waveform Parameters	40	4.00	10	1600.00
4355	Time of First Pulse	1	8.00	1	8.00
4355	Height Vector Use Flag	1	8.00	2	16.00
4355	Coordinate Data, POD	1	8.00	3	24.00
4355	Orbit Number	1	2.00	1	2.00

The specific details of Table 3-3 "GLAS Level 1 Standard Data Elements" assume an aggregation or assembly span of one-second. This table is ordered by the EOS Parameter Number and provides the Element Name, the number of Elements per Second,

the size in number of Bytes per Item, the number of Items per Element, and the Total Bytes required for the element within the one-second aggregation. The Total Bytes in the GLAS Data Element for the aggregation period are obtained by the multiplication of the Elements per Second times the Bytes per Item times the Items per Element. Figure 3-1 "Level 1 Data Products Composition & Terminology Pyramid" depicts the composition and the terminology used to represent the data products and their decomposition.
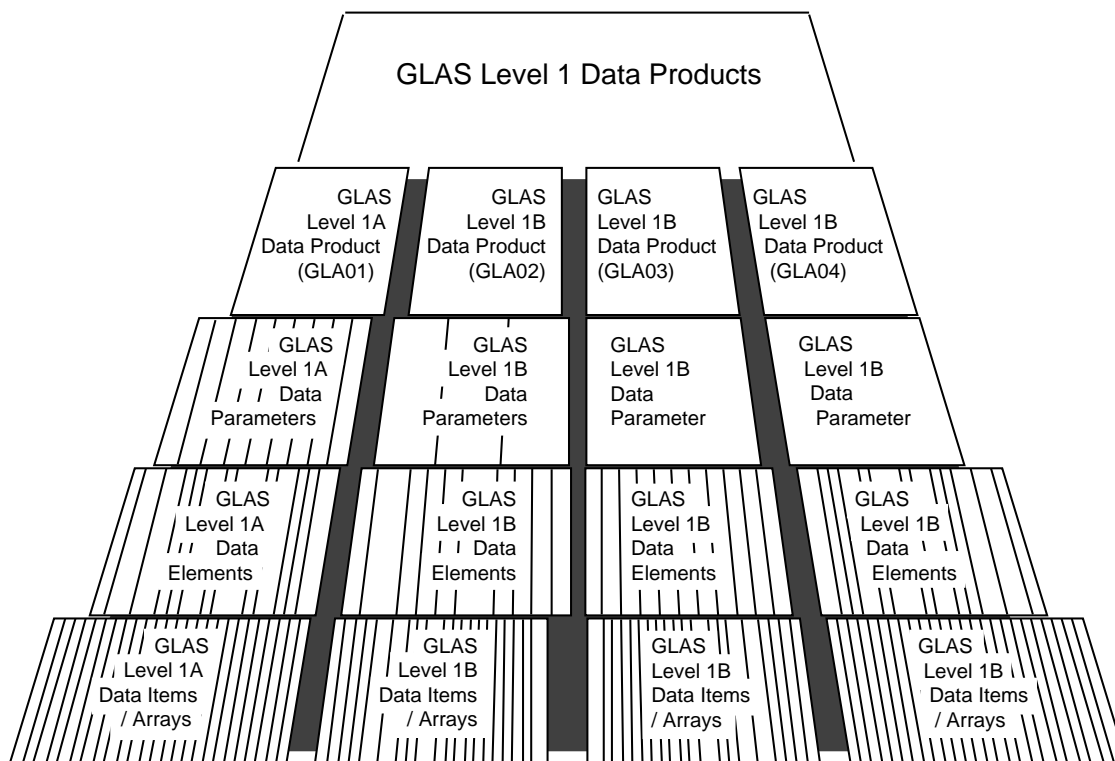
Figure 3-1 Level 1 Data Products Composition & Terminology Pyramid

The EOS Data Parameters are measurements and associated correction values obtained from specific GLAS science algorithm sets. In addition to the EOS Data Parameters, the Data Products will have associated standard EOS Data Header Labels containing identification, processing history, and data content descriptive information.

The input data source is obtained from the EDOS generated Level 0 data archived in the ECS DAAC storage system. The GLAS Ground Data System software transforms the instrument data into the appropriate time-ordered, along-track 1064 nanometer and 532 nanometer Level 1A and Level 1B data parameters and elements. Supplemental Level 1A science processing algorithms transform the GPS receiver data, the twin star camera data, 3-axis gyroscope data, and the angular displacement sensor

data for inclusion in the Level 1A product file records. Instrument engineering monitor data along with derived calibration data items are recorded.

Figure 3-2 "Level 1 Data Products Within the Processing Hierarchy" illustrates the source Level 0 data being processed to generate the Level 1A Data Product and two of the Level 1B Data Products on the ECS DAAC. These Level 1A and Level 1B Data Products are characteristically recorded with sufficient detail so as to allow the recovery of the original input elements. Following the generation of the Level 1A and Level 1B pass product files and in support of the GLAS Science Team, the GLAS GDS Operations Team performs quality assurance at the GLAS SCF and returns data quality and descriptive metadata to ECS for incorporation in the EOS data base system. The Level 1B correction data product is produced and quality monitored within the GLAS SCF. This Level 1B Data Product and its accompanying metadata are supplied to ECS for archival, completing the Level 1 processing activities.

The specific details of the data product structure, content, format, and data element details will be presented in Section 6. Data sizing, storage burden, and physical media details are provided in Section 5.
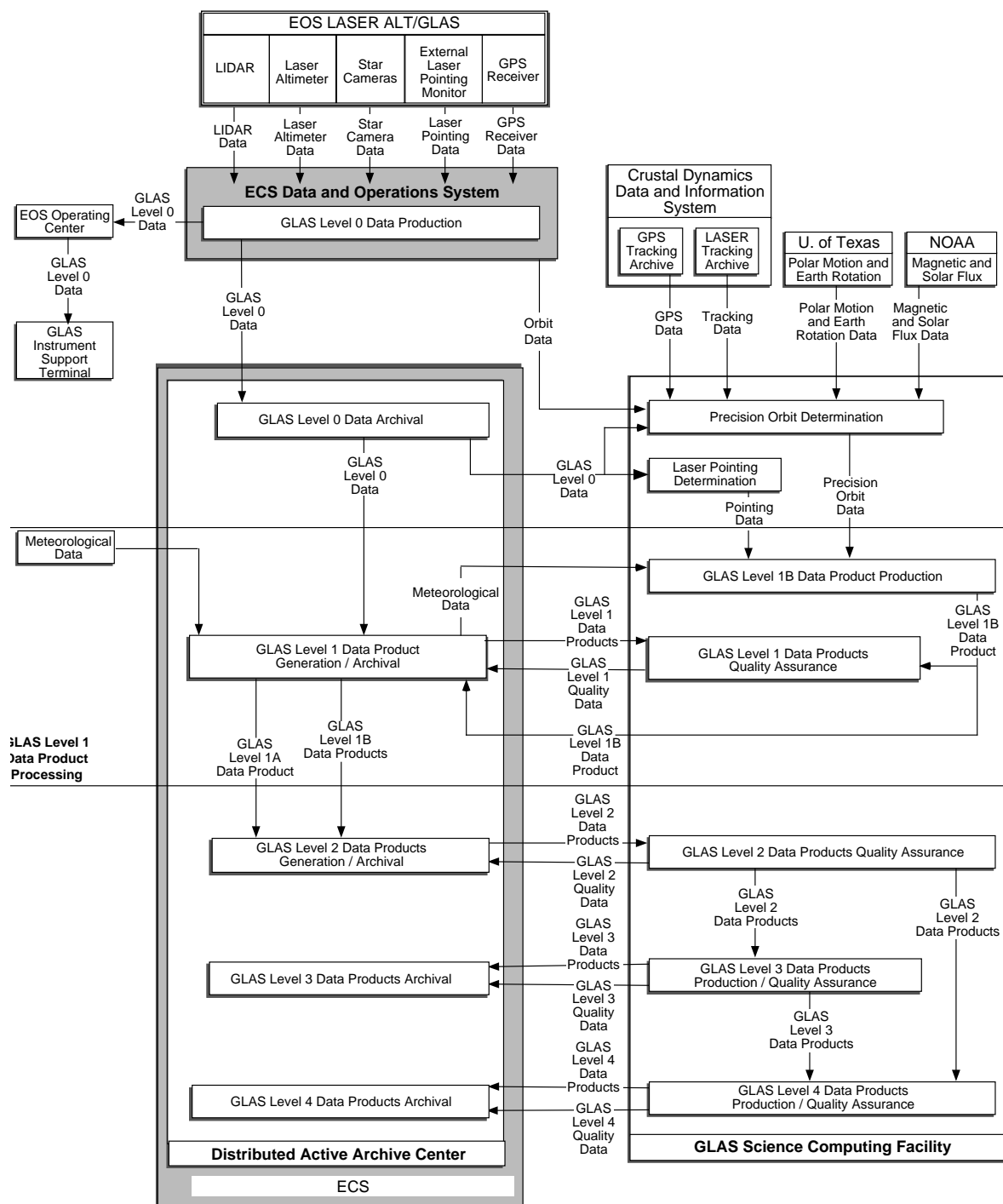
Figure 3-2 Level 1 Data Products Within the Processing Hierarchy

Environment

4.1 Hardware Characteristics and Limitations

The required input GLAS Level 0 Data are generated by the EOS Data and Operations System (EDOS), and delivered for archival in the ECS DAAC storage facilities. The GLAS Level 1A Standard Data Product and the production GLAS Level 1B Standard Data Products will be generated on the ECS DAAC or on the GLAS Science Computing Facility.

The newly generated Level 1A and Level 1B Data Products in the ECS DAAC are accessed for quality assurance (QA) monitoring through the GLAS SCF. The GLAS SCF consists of ECS-compatible UNIX systems that interface to the EOSDIS Network, and support the GLAS Science Team operations including the quality monitoring. The GLAS Level 1A and Level 1B Data Products and the QA monitoring data are available from the ECS DAAC archive facility.

The Science Team-produced Level 1B Data Product is generated within the GLAS SCF, quality assurance monitored within the SCF, and delivered to the ECS DAAC for GLAS Level 2 processing and archival in the DAAC storage facilities. The Level 1A and Level 1B associated data description and support information are included in the ESDIS data base to facilitate EOS client inquiry and retrieval activities. The distribution management function of the ECS DAAC allows clients to perform direct search and access of the Level 1A and Level 1B data or to request preparation of the Level 1A Data Product or Level 1B Data Products.

Figure 4-1 "Level 1 Data Products Flow Within the ECS DAAC and SCF Architecture" provides a block diagram of the relationship of the GLAS Level 1A Standard Data Product and the GLAS Level 1B Standard Data Products to the EDOS facility, the ECS DAAC facility and the GLAS Science Computing Facility.

4.2 Data Products Medium and Characteristics

The data products will be archived under the data collections within the ECS DAAC data storage and archival subsystem. The storage system will contain not only the Level 1A Data Product and the Level 1B Data Products, but will also contain data descriptions and data advertisements (i.e., textual descriptive and abstract information, also called metadata). The Level 1A Data Product and the Level 1B Data Products will be part of the Earth Sciences data collection while the information describing and documenting the data product will be a part of the supporting data base collection.

The Earth Science data are implemented in the current-EOSDIS system through a hierarchical storage manager interface. Physical media supported by the storage system interface will include the disk storage subsystems, magnetic or optical media subsystems, and tiered archive robotics storage subsystems. The ECS DAAC hierar-
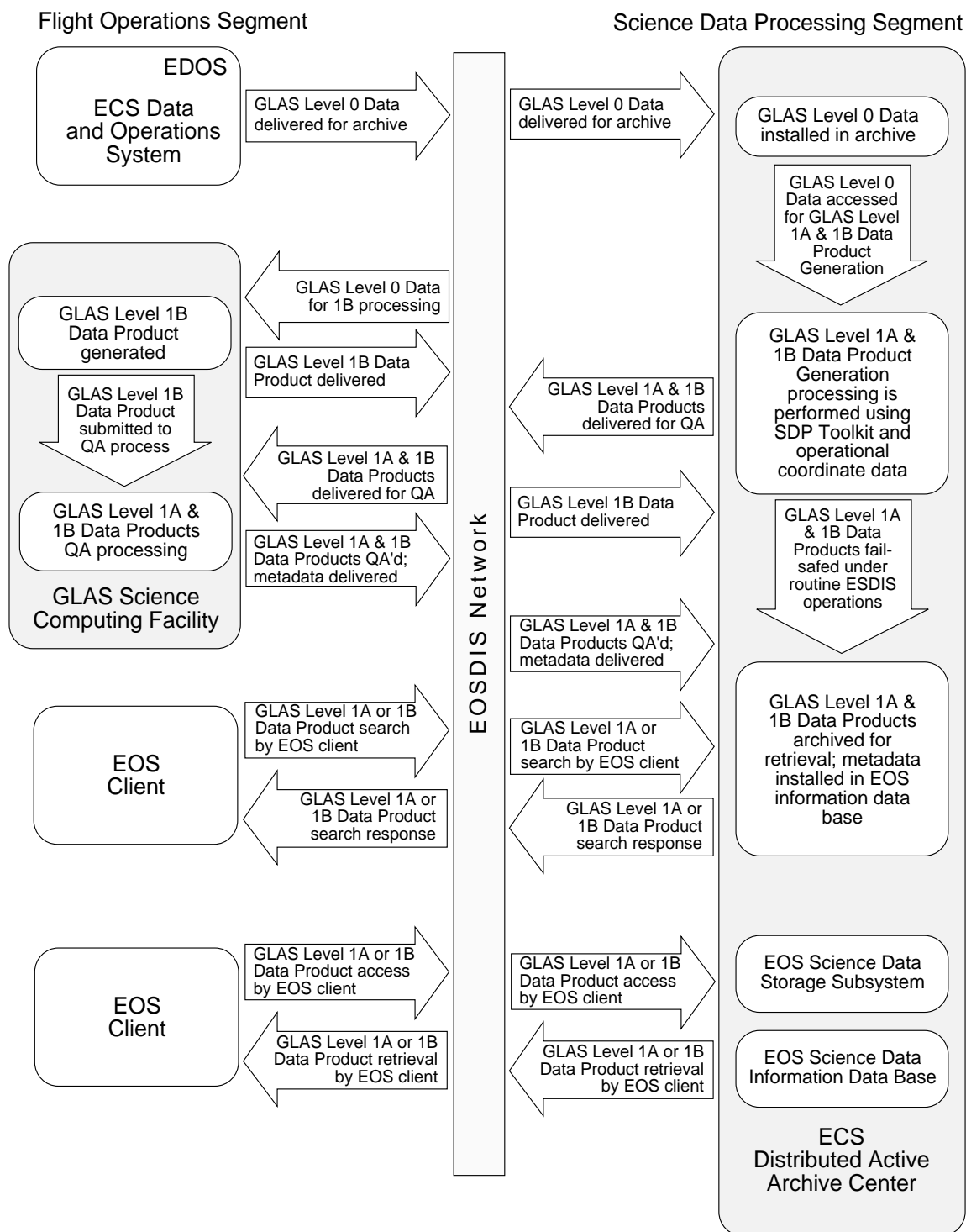
Figure 4-1 Level 1 Data Products Flow Within the ECS DAAC and SCF Architecture

chical storage arrangement consists of two functional subsystems: 1) the data repository subsystem, and 2) the working storage subsystem. Clients can directly access the GLAS Level 1A and Level 1B data from the storage system and can copy the data products to their host processors across the EOSDIS Networks.

4.3   Protocol and Conventions

The ECS DAAC facilities consist of distributed UNIX operating system-based computers. At the core of the DAAC architecture will be the file structures, operating system protocols, input/output protocols, device addressing, and data representation inherent in the standard UNIX environment. These UNIX protocols and conventions will be removed from direct access by ECS staff and client users through the subsystem applications, COTS packages, data managers, and data handlers installed on the DAAC subsystem components. The visible conventions and protocols then become those of the IST, SCF, and other EOS-supplied libraries (toolkits) provided to support the external data introduction, data storage and archival, data product generation processing, and EOS data client access through the various subsystems of the ECS DAAC architecture.

EOS and ESDIS specific protocols and conventions will be documented in the appropriate Project documentation. Specific topics for these documents are expected to be traceability notation, metadata, keyword/value conventions, file and record structure, EOF notation, markers, and label structure and content. Device addressing and input/output protocols will be presented in the Project documentation describing the specification and use of the EOSDIS supplied libraries (toolkits).

Data definition terminology specific to the GLAS Level 1A Data Product and the GLAS Level 1B Data Products is presented in the Glossary at the end of this document. Figure 4-2 "UNIX Data Representation" depicts a schematic of the standard UNIX data representations used in the GLAS Level 1A Data Product and the GLAS Level 1B Standard Data Products. These data structures will be used in the Section 6.0 generic data description and in the Appendix C detailed data description of the GLAS Level 1A Data Product and the GLAS Level 1B Data Products.

4.4   Failure Protection, Detection, and Recovery Features

GLAS Level 1A and Level 1B Data Products failure protection, detection, and recovery will be functions of the ECS Operations Team. The generated GLAS Level 1A and Level 1B Data Products will be "backed up" under the routine operational functions performed by the ECS DAAC processing subsystem. In the event of failure or error detection in the active working or archive storage containing GLAS Level 1A or Level 1B data at a specific DAAC site, recovery would be performed from backup media.

Initial GLAS Level 1A and Level 1B Data Products error detection is performed as part of the product quality assurance activity. The generated GLAS Level 1A and Level 1B Data Products are evaluated at the GLAS Science Computing Facility. Media failure, data drop-out, checksum errors, and data integrity checks will be reported as part of the routine ECS function. Should the need arise, GLAS ground data system

Data Types, Sizes, and Representations

Conventions: byte 0 is the most significant byte (MSB)
                bit 0 is the least significant bit (lsb)
                S = the sign bit

byte: 0   char

bit: 7 6 5 4 3 2 1 0

minimum value =   0
maximum value =   255

byte: 0   1   short integer

bit: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

minimum value =   -32768
maximum value =   32767

long integer

byte: 0   1   2   3

bit: 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

minimum value =   -2147483648
maximum value =   2147483647

float (IEEE)

byte: 0   1   2   3

exp (8) - 127   fraction (23)

bit: 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

minimum value = $-3.40282347 \times 10^{38}$
maximum value = $+3.40282347 \times 10^{38}$

double precision (IEEE)

byte: 0   1   2   3

exp (11) - 1023

bit: 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32   • • •

             4   5   6   7

fraction (52)

• • •

31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

minimum value = $-1.189731495357231765 \times 10^{4932}$
maximum value = $+1.189731495357231765 \times 10^{4932}$

Figure 4-2 UNIX Data Representation

support personnel will be available to assist ECS data specialists and product support personnel in determining the nature of an internal GLAS Level 1A or Level 1B Data Product problem.

The security and integrity of the GLAS Level 1A Data Product and the GLAS Level 1B Data Products will be protected by the working storage and archive schema of the DAAC data storage subsystem, and through the access and data management protocols established by the various EOSDIS and client data handling tools.

Data Flow Characteristics

5.1   Volume, Size, and Frequency Estimates

The expected daily data storage burdens for the GLAS Level 1A Standard Data Product and the GLAS Level 1B Standard Data Products are listed in Table 5-1 "GLAS Level 1 Data Product Daily Storage Burden". This estimate is based on the following EOS LASER ALT operational assumptions. The spacecraft will orbit the Earth at an inclination of 94 degrees and a nominal altitude of 705 kilometers in a circular orbit. The orbit (groundtrack) repeat cycle is one-half year based on a frozen orbit. The EOS LASER ALT orbit period will be approximately 100 minutes.

Table 5-1   GLAS Level 1 Data Product Daily Storage Burden

Product ID	Volume (MBytes per Day)
GLA01	2307.10
GLA02	33.52
GLA03	199.93
GLA04	475.89

5.2   Data Transfer and Transmission

The majority of data transfers within the EOSDIS architecture involving the GLAS Level 1A Standard Data Product and the GLAS Level 1B Standard Data Products will utilize the internal part of the EOS Science Network. The current Ethernet network access arrangement is based on the TCP/IP (or other) protocols and is performed using UNIX command operations, or will use tools implemented under the ECS DAAC. The GLAS Level 1A and Level 1B Data Products generated within the DAAC processing subsystem will be designated by the ECS Operations Team for fail-safe functions and for the GLAS Science Team product assurance support. The Science Team-produced Level 1B Data Products will be delivered to the ECS DAAC archival facility through the network access arrangement. GLAS Level 1A and Level 1B Data Products approved for archive installation and client access, and associated descriptive metadata for data base installation, are also delivered using the EOS Network.

Data access by EOS clientele for the purpose of retrieving the GLAS Level 1A Standard Data Product and the GLAS Level 1B Standard Data Products primarily uses the EOS Science Network. EOS clients will electronically retrieve the GLAS Level 1A and Level 1B data using UNIX network support commands or specialized tools supplying the data retrieval capability through the ECS DAAC Client support sub-

system. Alternately, the client may request media preparation for off-line delivery rather than the electronically transferred data. The client can request the preparation of magnetic or magneto-optical media containing the selected data products.

5.3   Timing and Sequencing Characteristics

The GLAS Level 1A Standard Data Product and the GLAS Level 1B Standard Data Products are generated as product files consisting of processed Level 0 data. The basic aggregation of the GLAS Level 1 Data Product is the EOS Data Parameters and GLAS Data Elements in the data records. Each record consists of one-second of reduced GLAS instrument, GPS receiver, star cameras, 3-axis gyroscope, angular displacement sensor, and EOS operational location data. The data parameters and elements contained within the record are groups of forty hertz, five hertz, and one hertz rate data. The data record will be identified by time tags referenced to the first forty hertz laser pulse travel time (range) element, the first five hertz aerosol element (referred to as first sample time), GPS receiver time, 3-axis gyroscope time, and angular displacement sensor time.

All data records within the GLAS Level 1A Data Product files will be in ascending time order based on the first pulse time tag or the first sample time tag. All parameters and elements contained within the records are synchronous at either forty hertz, five hertz, or one hertz. The GLAS instrument and the EOS LASER ALT spacecraft are expected to operate continuously over a five-year life.

5.4   Recipients and Utilization

The ESDIS Operations System is the initial recipient of the Level 1A Data Product and the Level 1B Data Products. ESDIS will perform the GLAS software processing required to generate the GLAS Level 2 Data Products using the GLAS Level 1A Data Product and the GLAS Level 1B Data Products as the primary inputs.

The next recipients of the GLAS Level 1A Data Product and the GLAS Level 1B Data Products will be the GLAS Science Team and the GLAS Ground Data System Operations Team charged with product quality assurance. The GLAS Science Team produces the Level 1B Data Product containing the non-instrument corrections within the GLAS SCF. The GLAS Science and GDS Team will perform data quality evaluation and statistical reporting on the GLAS Level 1A and Level 1B Data Products to quantify and qualify the products for EOS community usage. The subsequent audience for the GLAS Level 1A Data Product and the GLAS Level 1B Data Products is the scientific, governmental, and educational community sectors.

5.5   Access

While EOS is intended to be a globally available and utilized mission program, access to the data is still operated under a security and integrity program to protect the data and data system resources from unauthorized or destructive use. EOS has identified three classes of users who will have access to the data through the ECS DAAC; these

are 1) SCF users, 2) other scientists, and 3) guest users. These users will be enrolled under EOSDIS and receive individual access and authorization details under the Communications and Systems Management Segment security role. Users who are authorized EOS access can then avail themselves of the EOS services to retrieve the GLAS Level 1A Data Product and the GLAS Level 1B Data Products as well as to query the metadata (i.e., data description information) from the EOS Science data base management server.

Data Product Definitions

6.1 Data Product Structure

The GLAS Level 1A Standard Data Product will be generated as an EOSDIS standard header label file and an associated data product file, i.e., a collection of one-second records of GLAS instrument, sensor, and time data. The GLAS Level 1B Standard Data Products will also be generated as an EOSDIS standard header label file and a data product file. Within the one-second data record aggregate, data are collected in EOS data parameter groups.

The EOS Data Parameters as shown in Table 3-2 "GLAS Level 1 Standard Data Parameters" are further subdivided into the GLAS Data Elements identified in Table 3-3 "GLAS Level 1 Standard Data Elements". The data elements consist of measured or derived data values collected at the forty, five, or one hertz rate, and one of more items or arrays collected at that frequency. The data rate times the number of items establishes the total number of data items for a particular GLAS Data Element recorded in each one-second data record.

6.2 Labeling and Identification

Each of the GLAS Level 1A Data Product and the Level 1B Data Products is uniquely identified by a hierarchical data format (HDF) compliant file name. The form of this file name is

[filename example placeholder]

where [description of the subfields in the EOSDIS filename string placeholder].

The structure and contents of the EOSDIS standard product label file linked to each GLAS Level 1A and Level 1B Data Product are contained in Appendix A, GLAS Level 1 Data Product -- EOSDIS Standard Label -- Contents and Description. Within the standard product label, the following keyword/value fields uniquely identify the GLAS Level 1A or Level 1B Data Product.

- Instrument Name
- Product Creation Time
- Generating Algorithm Name
- Generating Algorithm Identification
- EOS LASER ALT Orbit Number
- EOS LASER ALT Pass Number
- Equator Crossing Time
- Equator Crossing Longitude

- First Data Point Time (First Laser Pulse or Sample Time)
- Last Data Point Time (Last Laser Pulse or Sample Time)

Discrete terminology has been applied to identify particular EOS Data Parameters and GLAS Data Elements as to the origin of the value within the GLAS instrument. The 1064 nanometer (nm) prefix has been attached to those elements associated with the instrument infrared (IR) spectrum wavelength. Alternately, this has been identified as the λ_1 wavelength and is occasionally referred to as the altimeter associated measurement. The 532 nm prefix has been attached to those GLAS data elements associated with the green spectrum. Alternately, this has been identified as the λ_2 wavelength and is occasionally referred to as the LIDAR associated measurement.

6.3　Data Product Substructure Descriptions

The EOSDIS standard data product label and headers file contain an aggregate of [TBD] records of string information (TBD bytes in length) describing the GLAS Level 1 Data Products. Appendix A provides the format of the standard label and headers file, including the keyword/value field contents.

The GLAS Level 1 Data Products file is linked to the EOSDIS standard product label file. Each aggregate or record consists of the GLAS instrument time tag element, measurement elements, and the derived and computed elements, as recorded, fitted, averaged, or derived at the forty hertz, five hertz, or one hertz rate. The specific layout, format, and content of the GLAS Level 1 Data Products aggregates or records are provided in Appendix B, GLAS Level 1 Data Products -- Format.

6.4　Detailed Data Descriptions

The detailed information describing the GLAS Level 1 Data Products comprising the data elements and the contents of the one-second data collection is provided as a data dictionary in Appendix C, GLAS Level 1 Data Products -- Detailed Data Contents and Description.

Table 6-1: "GLAS Terms and Explanations" is provided as a road map for the detailed descriptions presented in Appendix C.

Table 6-1: GLAS Terms and Explanations

Data Detail Field	Explanation
Element Name	the GLAS Data Element name, describes the unique GLAS item, items, or array as a member of the GLAS Data Parameter collection
Product Identification	the EOS Data Product Identification label of the Data Product containing the GLAS Data Element and the GLAS Data Parameter, obtained from the EOS Senior Project Scientist List of Data Products
Parameter Number	the unique GLAS Data Parameter identification number used to denote the collection or group of which the GLAS Data Element is a member
Description	a text description of the contents and discipline interest of the GLAS instrument or sensor data element
Minimum Value	the lowest representable value within the data element or the actual physical element minimum value based on the units configuration
Nominal Value	the routine expected value for the data element
Maximum Value	the largest representable value within the data element or the actual largest physical data element value based on the units configuration
Elements/Second	the number of times the GLAS Data Element is repeated in the record expressed as rate, per second (e.g., 5 for five elements per second)
Units	the output measurement units for the GLAS Data Element as it appears on the record in the data product (e.g., millimeters)
Items/Element	the number of data items (values) or arrays of values contained in the record for the GLAS Data Element (e.g., 2 for two items per element)
Precision	the required representation resolution of the least significant digit of the measurement for the GLAS Data Element value (e.g., 1 millisecond)
Bytes/Item	the size of each data item (value) contained in the GLAS Data Element, expressed in bytes

Appendix A
Level 1 Data Products
EOSDIS Standard Label -
Contents & Description

To Be Provided

Appendix B
Level 1 Data Products
Format

To Be Provided

Appendix C
Level 1 Data Products
Detailed Data Contents & Description

Element Name　　　　　　　　*Product Identification*　　　　*Parameter Number*
　　　　Description
　　　　　　　Minimum Value　　　　*Nominal Value*　　　　*Maximum Value*
　　　　　　　Elements/Second　　　　*Units*
　　　　　　　Items/Element　　　　*Precision*
　　　　　　　Bytes/Item

Table C-1　GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

1064 nm Background Signal　　　　　　　　　　　GLA01　　　　　4346

The 1064 nm background signal or noise energy level sampled in the waveform digitizer noise bins as counts per second; includes solar background, optical, and thermal noise.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	counts/sec
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

1064 nm Cloud Waveform　　　　　　　　　　　　GLA01　　　　　4347

Waveform of the 1064 nm lidar data from the SiAPD detector, return signal as a function of 2-way ranging time over equivalent of 20 km range.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	30	Precision:	
Bytes/Item:	1.00		

1064 nm Cloud Waveform Quality Flag　　　　　　GLA01　　　　　4347

1064 nm data quality flag; indicates data quality based on good vs. bad data criteria.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	5	Precision:	
Bytes/Item:	8.00		

1064 nm Cloud Waveform Scaling Factor　　　　　GLA01　　　　　4347

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

The 1064 nm cloud waveform scaling factor, to avoid rollover from cloud waveform digitizer output.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

1064 nm Cloud Waveform Use Flag   GLA01   4347

1064 nm data use flag showing discipline and coverage applicability.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	5	Precision:	
Bytes/Item:	8.00		

1064 nm Laser Start Detector Threshold   GLA01   4345

The laser start detector threshold setting.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

1064 nm Laser Transmit Energy   GLA01   4345

The 1064 nm transmitted laser pulse energy in energy units, converted from the raw counts from the transmitted energy monitor.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	mJ
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

1064 nm Laser Transmit Energy, counts   GLA01   4345

The 1064 nm transmitted laser pulse energy, in raw counts from the transmitted energy monitor.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	counts
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

1064 nm Range Received Energy   GLA01   4346

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

The 1064 nm altimeter return pulse energy in energy units, converted from the raw counts from the 1064 nm received energy monitor.

Min/Nom/Max Value:	0.00		0.00	0.00
Element/Second:	40	Units:		pJ
Items/Element:	1	Precision:		
Bytes/Item:	4.00			

1064 nm Range Received Energy, Counts   GLA01   4346

The 1064 nm altimeter return pulse energy, in raw counts from the 1064 nm received energy monitor.

Min/Nom/Max Value:	0.00		0.00	0.00
Element/Second:	40	Units:		counts
Items/Element:	1	Precision:		
Bytes/Item:	2.00			

1064 nm Range TIU Time   GLA01   4343

The 1064 nm laser pulse two-way travel time, from the coarse and fine Timing Interval Unit (TIU).

Min/Nom/Max Value:	0.00		0.00	0.00
Element/Second:	40	Units:		ns
Items/Element:	1	Precision:		
Bytes/Item:	4.00			

1064 nm Range Travel Time Correction   GLA01   4343

The additive correction applied to the 1064 nm laser pulse round-trip travel time, the sum of instrument system delay and discriminator time walk terms.

Min/Nom/Max Value:	0.00		0.00	0.00
Element/Second:	40	Units:		ns
Items/Element:	1	Precision:		
Bytes/Item:	4.00			

1064 nm Range Waveform   GLA01   4344

The 1064 nm return waveform digitizer sample output, reduced to 400 samples per shot, to provide the ice sheet surface/vegetation canopy profile.

Min/Nom/Max Value:	0.00		0.00	0.00
Element/Second:	40	Units:		
Items/Element:	400	Precision:		

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Bytes/Item:	1.00	

1064 nm Range Waveform Multiplier   GLA01   4344

The range width of each 1064 nm return waveform bin, in time units.

Min/Nom/Max Value:	0.00	0.00		0.00
Element/Second:	40	Units:		ns
Items/Element:	1	Precision:		
Bytes/Item:	1.00			

1064 nm Range Waveform Scaling Factor   GLA01   4344

The 1064 nm range waveform scaling factor, to avoid rollover from the waveform digitizer output.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

1064 nm Range Waveform Threshold   GLA01   4344

The 1064 nm threshold detector setting value.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	2	Units:	
Items/Element:	4	Precision:	
Bytes/Item:	1.00		

532 nm Atmosphere Signal Histogram   GLA01   4347

Histogram of the 532 nm lidar data from photon counting detector, expressed as number of photons as function of 2-way ranging time, over the equivalent of 40 km range.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	
Items/Element:	535	Precision:	
Bytes/Item:	2.00		

532 nm Atmosphere Signal Histogram Scaling Factor   GLA01   4347

532 nm histogram scaling factor, to avoid rollover from the photon counter output.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	
Items/Element:	1	Precision:	

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Bytes/Item:	1.00		

532 nm Channel Received Energy   GLA01   4346

The 532 nm laser return pulse energy in energy units, converted from the raw counts from the 532 nm received energy monitor.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	pJ
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

532 nm Channel Received Energy, counts   GLA01   4346

The 532 nm laser return pulse energy, in raw counts from the 532 nm received energy monitor.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	counts
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

532 nm Laser Transmit Energy   GLA01   4345

The 532 nm transmitted pulse energy in energy units, converted from the counts from the transmitted energy monitor.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	mJ
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

532 nm Laser Transmit Energy, counts   GLA01   4345

The 532 nm transmitted pulse energy, in raw counts from the transmitted pulse energy monitor.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	counts
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Attenuated Backscatter Vertical Profile Quality Flag   GLA04   2104

532 nm data quality flag; indicates data quality based on good vs. bad data criteria.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	5	Precision:	

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Bytes/Item:	8.00		

Attenuated Backscatter Vertical Profile Use Flag   GLA04   2104

532 nm data use flag showing discipline and coverage applicability.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	5	Precision:	
Bytes/Item:	8.00		

Attenuated Backscatter Vertical Profile   GLA04   2104

Atmosphere 532 nm laser backscatter decay profile computed from the photon count and corrected for optical noise induced by solar radiance at the surface and scaled by the calibration value and the normalized transmit power, group of 5 per 1 second.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	
Items/Element:	535	Precision:	
Bytes/Item:	2.00		

Background Noise Counter   GLA01   4343

The background noise counter at the 2 Hz update rate.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	2	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Background Radiance   GLA04   2104

Radiant energy emitted by the illuminated surface in the direction of the instrument receiver, group of 5 per 1 second.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	4.00		

Calibration Mode (OTS)   GLA01   4351

The set of data acquired in calibration modes of the instrument, including a time tag.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Items/Element:	100	Precision:	
Bytes/Item:	2.00		

Carrier Phase L1   GLA01   4349

Global Positioning System receiver carrier phase L1 for up to 12 GPS satellites.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	12	Precision:	
Bytes/Item:	8.00		

Carrier Phase L2   GLA01   4349

Global Positioning System receiver carrier phase L2 for up to 12 GPS satellites.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	12	Precision:	
Bytes/Item:	8.00		

Channel Number   GLA01   4343

The trigger channel ID.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	0.50		

Cloud Delta Range from 1064 nm   GLA01   4348

The individual 1064 nm shot-to-shot cloud range differences from the 1-frame cloud height, in ranging time units.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	ns
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Coordinate Data, POD   GLA04   2104

Spacecraft location data at first pulse time tag, consisting of latitude, longitude, and spacecraft altitude (from Precision Orbit Determination software).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Items/Element:	3	Precision:	
Bytes/Item:	8.00		

Coordinate Data, POD   GLA03   4355

Spacecraft location data at first pulse time tag, consisting of latitude, longitude, and spacecraft altitude (from Precision Orbit Determination software).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	3	Precision:	
Bytes/Item:	8.00		

Coordinate Data, POD   GLA02   4352

Spacecraft location data at first pulse time tag, consisting of latitude, longitude, and spacecraft altitude (from Precision Orbit Determination software).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	3	Precision:	
Bytes/Item:	8.00		

Coordinate Data, POD, Quality Flag   GLA02   4352

POD orbit quality flag.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Engineering   GLA01   4351

The engineering data including time tag, status words and data from temperature, voltage, and current monitors in the instrument.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	100	Precision:	
Bytes/Item:	2.00		

External Laser Pointing Monitor   GLA01   4350

The external laser pointing monitor output.

Min/Nom/Max Value:	0.00	0.00	0.00

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Element/Second:	40	Units:	
Items/Element:	4	Precision:	
Bytes/Item:	1.25		

GPS ID   GLA01   4349

Global Positioning System receiver GPS Identification for up to 12 GPS satellites.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	12	Precision:	
Bytes/Item:	1.00		

GPS Quality Flag   GLA01   4349

GPS data quality flag for up to 12 GPS satellites. Each satellite is represented by a 5 bit flag.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	8.00		

GPS SNR   GLA01   4349

The GPS signal to noise ratio for up to 12 GPS satellites.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	12	Precision:	
Bytes/Item:	1.00		

GPS Time   GLA01   4349

The time tag of the first GPS receiver data in the 1-second data frame, in CCSDS day segmented binary form for up to 12 GPS satellites.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	ns
Items/Element:	12	Precision:	
Bytes/Item:	8.00		

Height Vector   GLA03   4355

One-second group of surface height vectors in the IERS Terrestrial Reference Frame, with the Earth center-of-mass as the origin in X, Y, and Z coordinates; determined from the intersection of the surface and the laser range vector corrected for atmospheric delay, laser pointing angles, and instrument calibration factors.

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	3	Precision:	
Bytes/Item:	4.00		

Height Vector Correction, Atmosphere		GLA03	4355

Atmospheric delay correction factor applied to the altimeter height vector group; includes ionospheric, and wet and dry tropospheric delay correction factors.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Height Vector Correction, Calibration		GLA03	4355

Correction factor applied to the height vector group based on instrument calibration and verification, including range and energy contributions such as bias, and range walk.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Height Vector Correction, Laser Pointing		GLA03	4355

Per-pulse correction applied to each laser range-derived height vector in the 1-second group, based on the laser pointing angle at each height vector at the surface return time.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Height Vector Quality Flag		GLA03	4355

The data quality flag for the height vector group; indicates data quality based on good vs. bad pulse criteria, including range and energy thresholds and limits.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	8.00		

Height Vector Use Flag		GLA03	4355

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Height vector group use flag showing discipline and coverage applicability; includes aerosols, vegetation canopy, ice sheet or land topography interest, land/ice, land/ocean, ocean, deep water, clouds/boundary.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	8.00		

Laser Pointing	GLA02	4353

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	4.00		

Laser Shot GPS Timing Vernier	GLA01	4343

The laser shot GPS timing vernier to 1 microsecond accuracy.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.50		

Meteorological Data	GLA02	4354

The meteorological data includes pressure, height of surface on which pressure is given, temperature, relative humidity, and lapse rate.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	5	Precision:	
Bytes/Item:	4.00		

Meteorological Data Quality Flag	GLA02	4354

Flag indicating quality and source of the meteorological data.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Orbit Number   GLA02   4352

The EOSDIS-assigned EOS ALT orbit reference number (obtained from EOSDIS library calls and EOS ephemeris data). Orbit numbers for 5+ years can be stored in 16 bits (as either signed or unsigned integer).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Orbit Number   GLA04   2104

The EOSDIS-assigned EOS ALT orbit reference number (obtained from EOSDIS library calls and EOS ephemeris data). Orbit numbers for 5+ years can be stored in 16 bits (as either signed or unsigned integer).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Orbit Number   GLA03   4355

The EOSDIS-assigned EOS ALT orbit reference number (obtained from EOSDIS library calls and EOS ephemeris data). Orbit numbers for 5+ years can be stored in 16 bits (as either signed or unsigned integer).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Pseudorange L1   GLA01   4349

Global Positioning System receiver pseudorange L1 for up to 12 GPS satellites.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	12	Precision:	
Bytes/Item:	8.00		

Pseudorange L2   GLA01   4349

Global Positioning System receiver pseudorange L2 for up to 12 GPS satellites.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Items/Element:	12	Precision:	
Bytes/Item:	8.00		

Range Gate Delay   GLA01   4343

The range gate delay. The start of the range gate.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	2	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Range Gate Width   GLA01   4343

The range gate width.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	2	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		

Range Pulse Quality Flag   GLA01   4343

TBD

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	6	Precision:	
Bytes/Item:	8.00		

Range Pulse Use Flag   GLA01   4343

TBD

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	6	Precision:	
Bytes/Item:	8.00		

Range Waveform Parameters   GLA03   4355

Parameters derived from processing the waveform digitizer data; used in timing and ranging data corrections.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	10	Precision:	

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Bytes/Item:	4.00			

Return Pulse Quality Flag			GLA01	4343

Data quality flag; indicates data quality based on good vs. bad data criteria.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	6	Precision:	
Bytes/Item:	8.00		

Return Pulse Use Flag			GLA01	4343

Use flag showing discipline and coverage applicability.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	6	Precision:	
Bytes/Item:	8.00		

Solar Angle			GLA04	2104

Solar angle.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Star (Laser) Coordinate X			GLA01	4350

X-coordinate data from 2 star cameras; each camera provides x-coordinate, y-coordinate, and intensity data for 6 targets (5 stars plus the laser).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	10	Units:	
Items/Element:	12	Precision:	
Bytes/Item:	2.00		

Star (Laser) Coordinate Y			GLA01	4350

Y-coordinate data from 2 star cameras; each camera provides x-coordinate, y-coordinate, and intensity data for 6 targets (5 stars plus the laser).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	10	Units:	
Items/Element:	12	Precision:	

Table C-1   GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Bytes/Item:	2.00	

Star (Laser) Intensity   GLA01   4350

Intensity data from 2 star cameras; each camera provides x-coordinate, y-coordinate, and intensity data for 6 targets (5 stars plus the laser).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	10	Units:	
Items/Element:	12	Precision:	
Bytes/Item:	1.00		

Star Camera Image   GLA01   4350

One line of the star camera image. Each star camera image is 512X512 pixels. Each pixel is represented by 8 bits. It will take 512 packets to obtain one image (approx. 8.5 minutes).

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	512	Precision:	
Bytes/Item:	1.00		

Star Camera Time   GLA01   4350

The time tag of the first star tracker readout in the 1-second data frame, in CCSDS day segmented binary form.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	10	Units:	ns
Items/Element:	2	Precision:	
Bytes/Item:	8.00		

Status Flags   GLA01   4343

Status flags from telemetry data. Indicate tracking / acquisition, overflow, etc. Details TBD.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

Telemetry Headers   GLA01   4351

Spacecraft and ground station header information, containing factors to be applied to GLAS raw telemetry data.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	

Table C-1 GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Items/Element:	100	Precision:	
Bytes/Item:	1.00		

Threshold Cloud Top Height from 1064 nm   GLA01   4348

The 1064 nm LIDAR-detected cloud height from the Earth surface, based on instrument-to-cloud-top ranging, in ranging time units.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	ns
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Threshold D/A Setting   GLA01   4348

The threshold D/A setting at the 1 Hz update rate.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	2	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

Time Correction   GLA01   4343

The additive time tag correction applied to the first laser pulse time tag, the sum of system internal and one-way transit delay terms.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	ns
Items/Element:	1	Precision:	
Bytes/Item:	4.00		

Time of First Pulse   GLA01   4343

The time tag of the first laser pulse in the 1-second data frame, corrected for system and transit delay, in CCSDS day segmented binary form.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	ns
Items/Element:	1	Precision:	
Bytes/Item:	8.00		

Time of First Pulse   GLA03   4355

The time tag of the first laser pulse in the 1-second data frame, corrected for system and transit delay, in CCSDS day segmented binary form.

Min/Nom/Max Value:	0.00	0.00	0.00

Table C-1 GLAS LEVEL 1 DATA PRODUCTS -- DETAILED CONTENTS AND DESCRIPTION

Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	8.00		

Time of First Pulse   GLA02   4353

The time tag of the first laser pulse in the 1-second data frame, corrected for system and transit delay, in CCSDS day segmented binary form.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	8.00		

Time of First Sample   GLA04   2104

The time tag of the first data sample at the 5 Hertz data rate, in CCSDS day segmented binary form.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	8.00		

Time, POD   GLA02   4352

Time tag of the PO data; in CCSDS day segmented binary form.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	8.00		

Abbreviations & Acronyms

ALT	EOS LASER Altimeter spacecraft series
DAAC	Distributed Active Archive Center
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
GDS	GLAS Ground Data System
GLAS	Geoscience Laser Altimeter System
GPS	Global Positioning System
GSFC	NASA Goddard Space Flight Center at Greenbelt, Maryland
GSFC/WFF	NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia
HDF	Hierarchical Data Format
ID	Identification
IEEE	Institute for Electronics and Electrical Engineering
IST	GLAS Instrument Support Terminal
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
POD	Precision Orbit Determination
QA	Quality Assurance
SCF	GLAS investigation Science Computing Facility and workstation(s)
SDPS	Science Data Processing Segment
TBD	to be determined, to be done, or to be developed
UNIX	the operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division

Glossary

aggregate
: A collection, assemblage, or grouping of distinct data parts together to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.

array
: An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.

file
: A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file. Loosely employed it is used to indicate a collection of GLAS data records without a standard label. For the Level 1A Data Product, the file would constitute the collection of one-second Level 1A data records generated in the SDPS working storage for a single pass.

header
: A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.

item
: Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.

label
: The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A standard label may imply a standard data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.

Level 0
: The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.

Level 1A
: The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.

Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.
Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and geo-reference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS LASER ALT spacecraft each orbit revolution count starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or con-straining data unit associated with a EOS science community approved algo-rithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements.
pass	A sub-segment of an orbit, it may consist of the ascending or descending por-tion of an orbit (e.g., a descending pass would consist of the ground track seg-ment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the SDPS or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate a single pass file aggregation, or the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.

Standard Data   Specifically, a GLAS Standard Data Product. It represents an EOS LASER ALT/
Product   GLAS Data Product produced on the EOSDIS SDPS for GLAS data product
                       generation or within the GLAS Science Computing Facility using EOS science
                       community approved algorithms. It is routinely produced and is intended to be
                       archived in the EOSDIS data repository for EOS user community-wide access
                       and retrieval.

variable   Usually a reference in a computer program to a storage location.